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**Jones et al.**

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[45] **Date of Patent: Mar. 3, 1992**

[54] **CONTAINER HANDLING APPARATUS FOR A REFUSE COLLECTION VEHICLE**

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[51] **Int. Cl.**[5] ..... **B65F 3/06**; B66C 1/44

[52] **U.S. Cl.** ..... **414/406**; 294/88; 294/106; 414/409; 414/422

[58] **Field of Search** ..... 294/68.3, 88, 99.1, 294/106, 115, 116, 902; 414/403, 406, 408, 409, 422, 555, 619–621, 729, 733, 739

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*Primary Examiner*—Johnny D. Cherry

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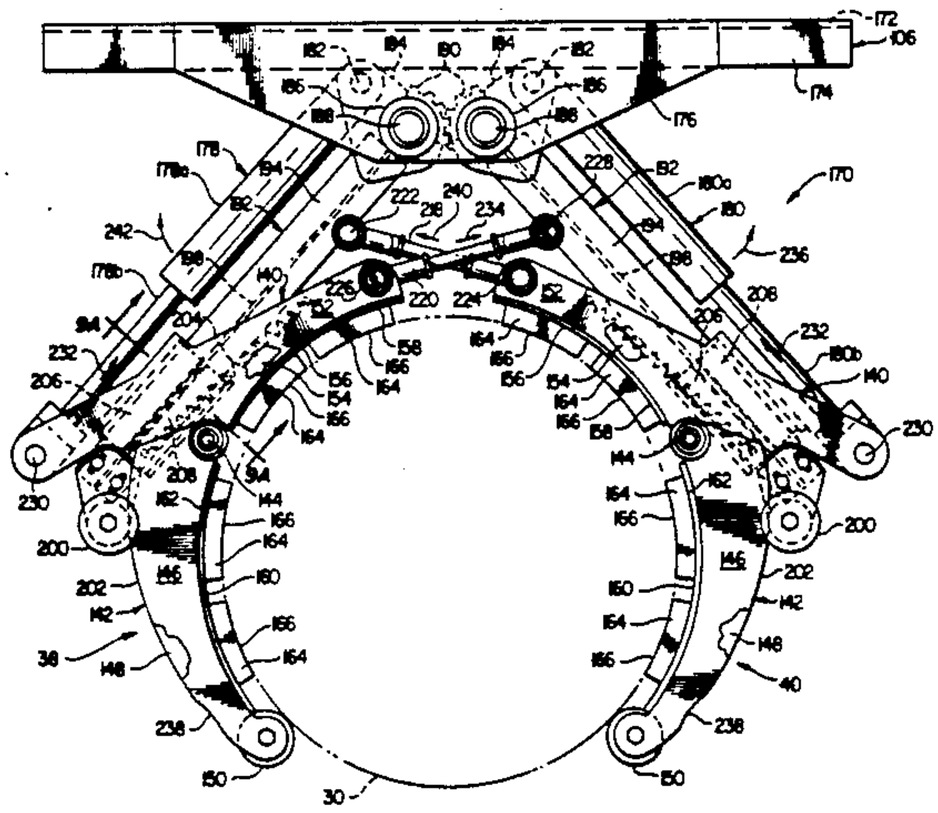
[57] **ABSTRACT**

A mechanized container handling system on a motorized refuse collection vehicle includes a horizontally extensible and retractable support structure having an outer end on which a container grasping assembly is carried, and a container elevating and dumping assembly for lifting the grasped container and dumping its contents into an elevated hopper opening of the vehicle. The support structure comprises telescoped inner, intermediate and outer sections interconnected by an extension scissors structure, the intermediate section being horizontally driven by a hydraulic actuator and the scissors structure being operative to responsively extend and retract the outer section. The container elevating and dumping system is driven by a hydraulic piston and gear system positioned between the upper ends of a pair of support tracks and drivingly connected to a pair of articulated container lifting force arms. The container grasping assembly includes a pair of hydraulically pivotable articulated engagement arms having a spaced series of resilient container gripping members secured to inner side surfaces thereof, for liftingly engaging cylindrical refuse containers, and suitable engagement structure may be added for handling larger rectangular containers. The power and control portions of the hydraulic system used to operate the apparatus may be conveniently housed in a lift-off module detachably secured to the refuse collection vehicle.

**34 Claims, 5 Drawing Sheets**



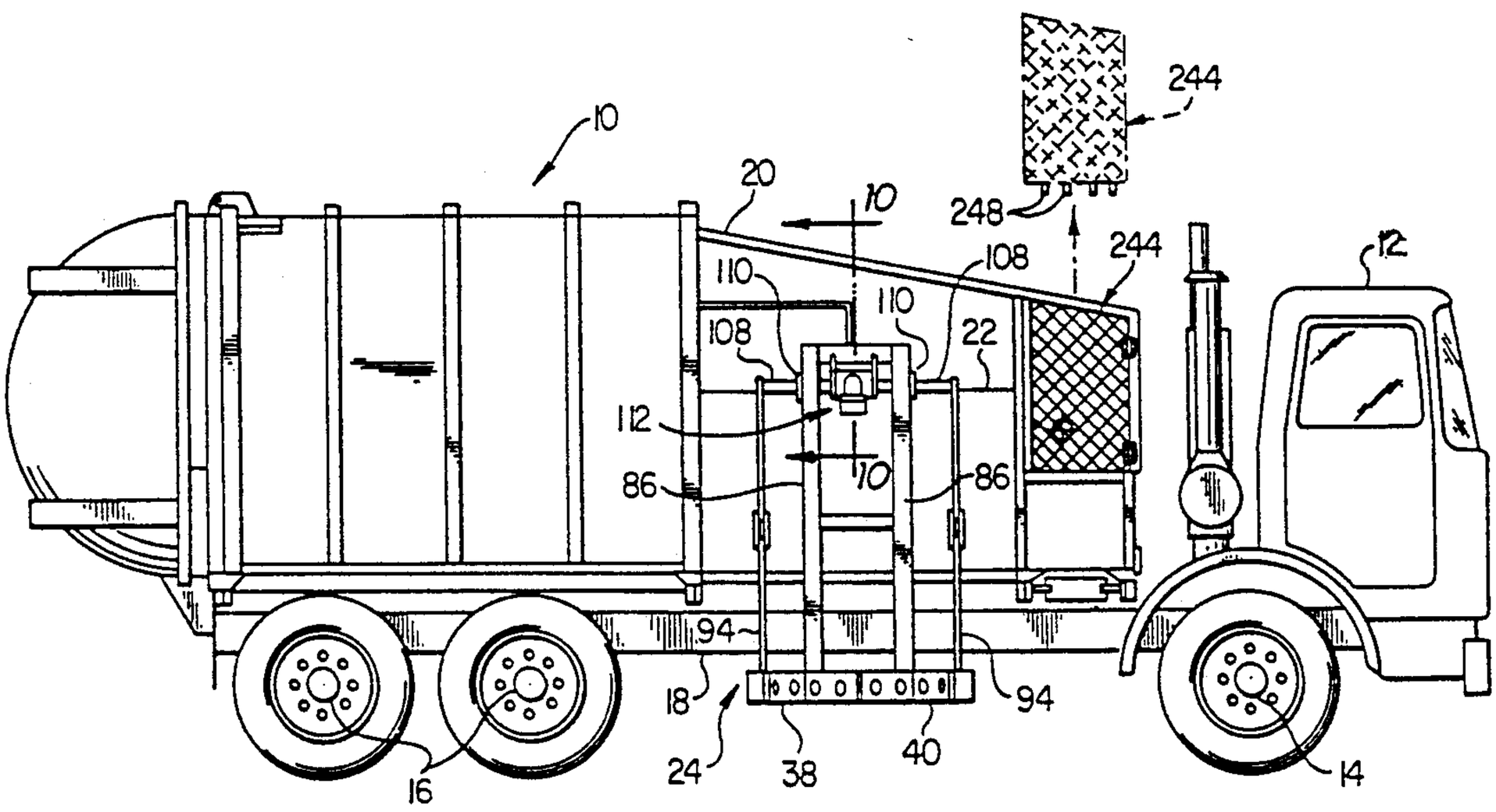

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FIG. 1

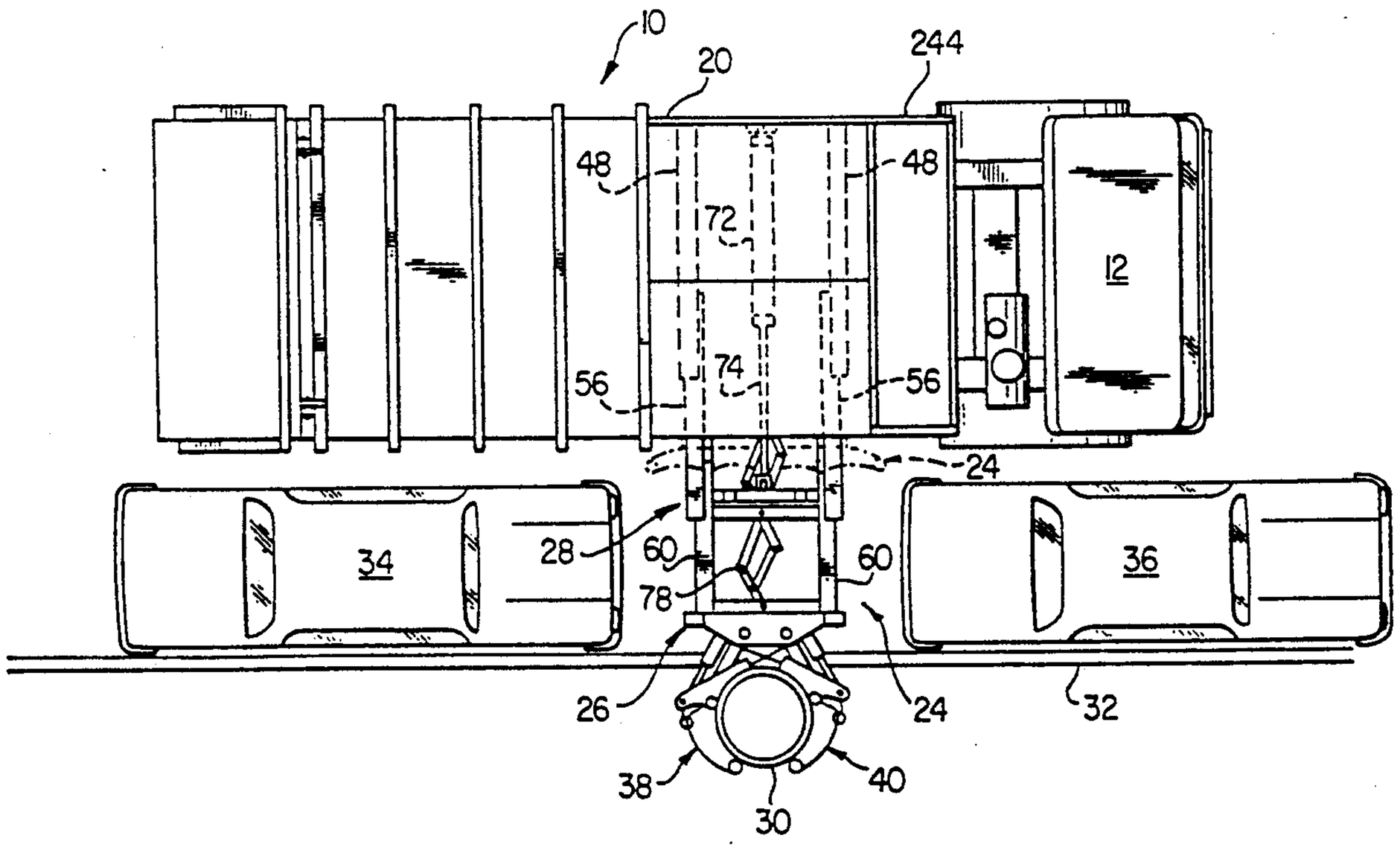
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FIG. 2

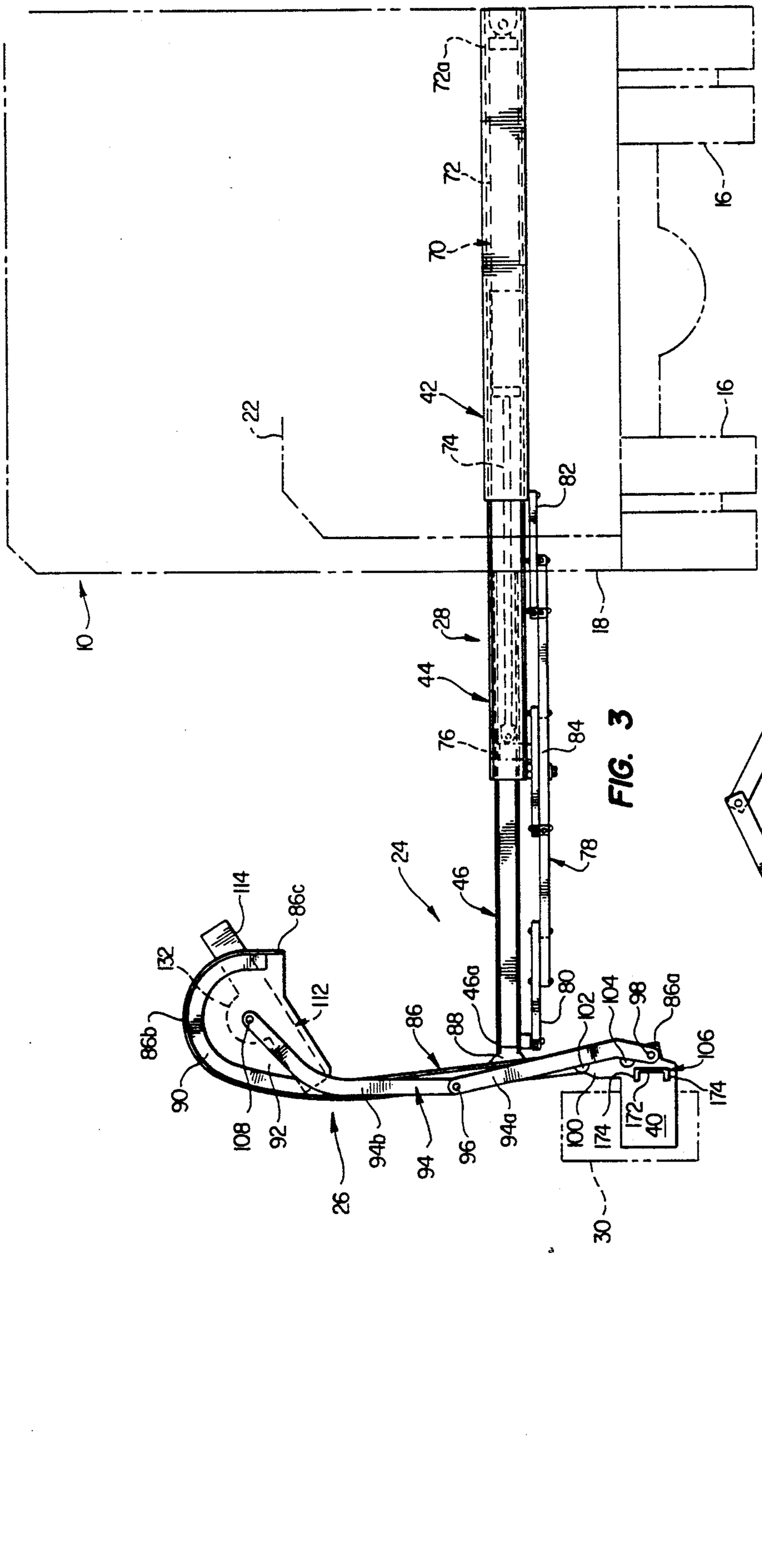
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FIG. 3

FIG. 4

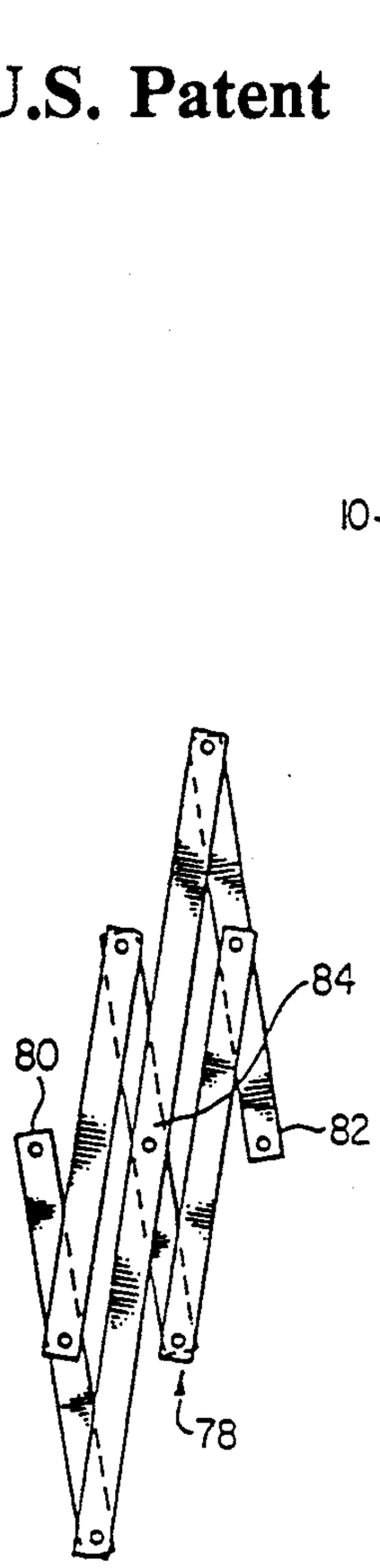


FIG. 6

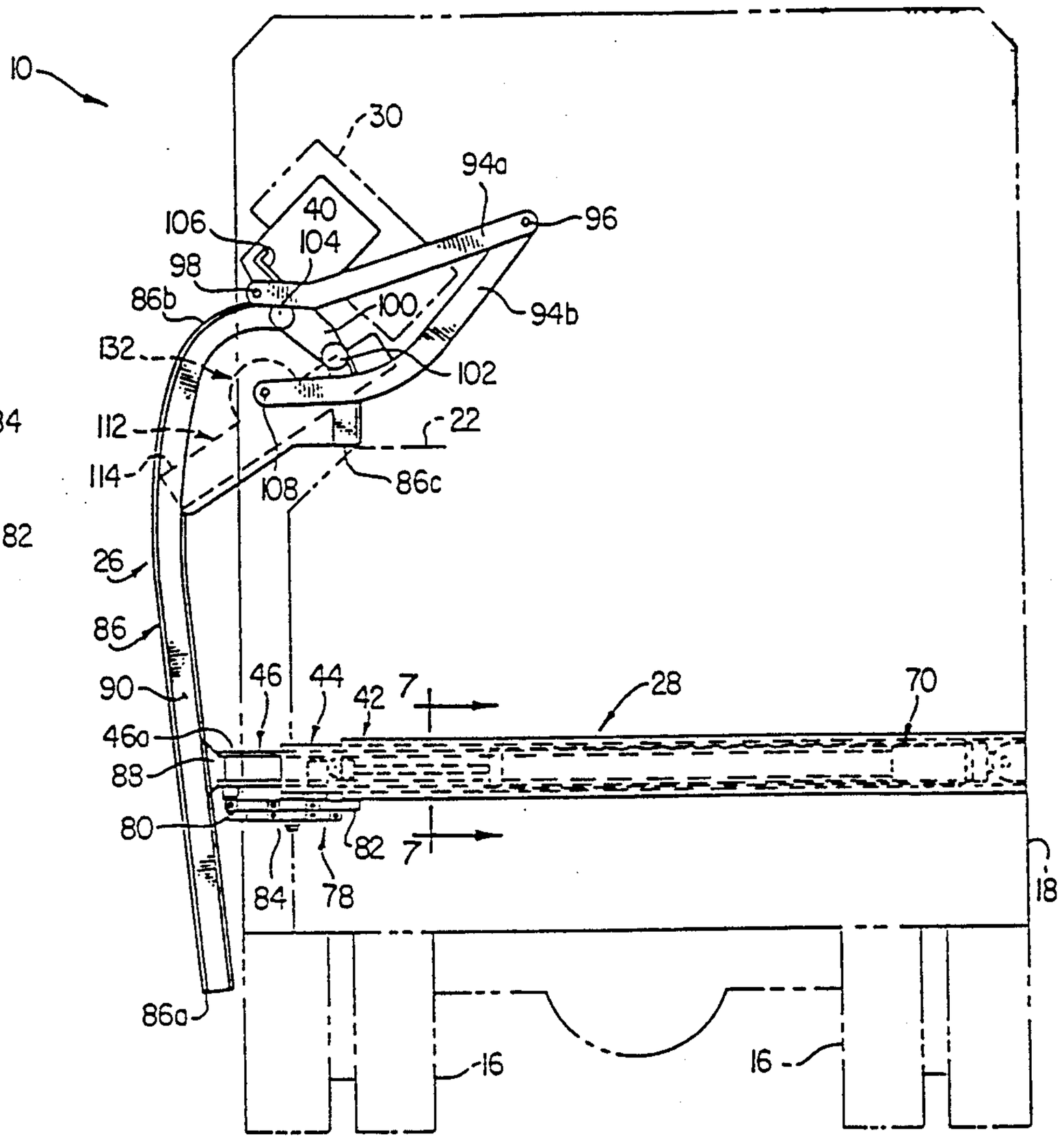


FIG. 5

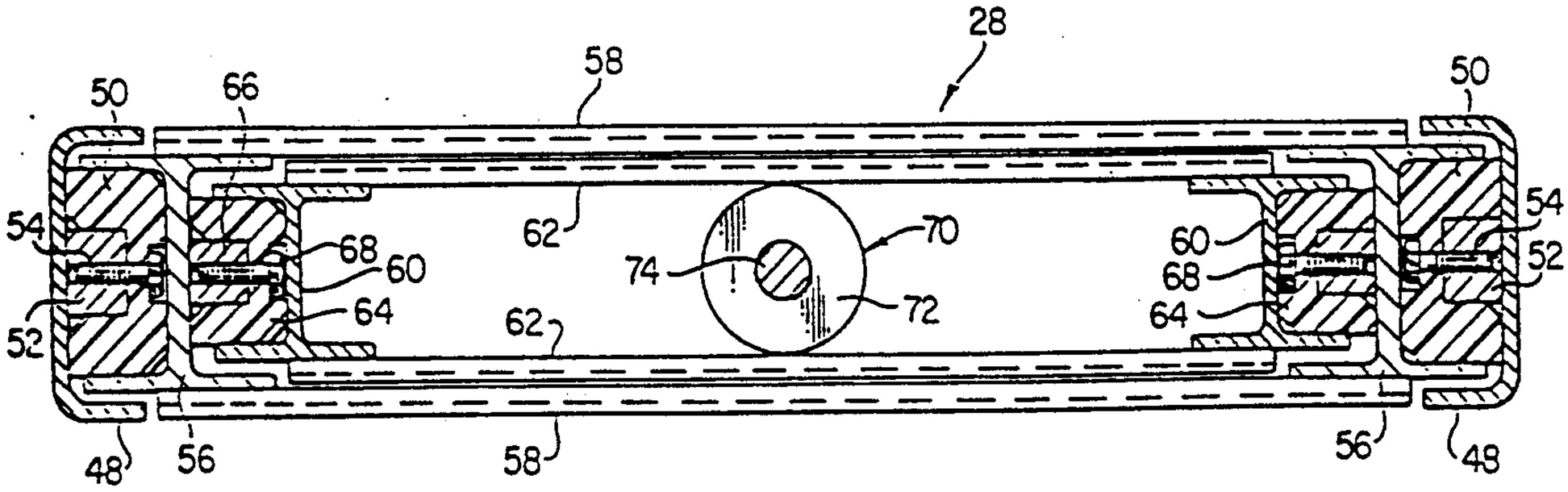


FIG. 7

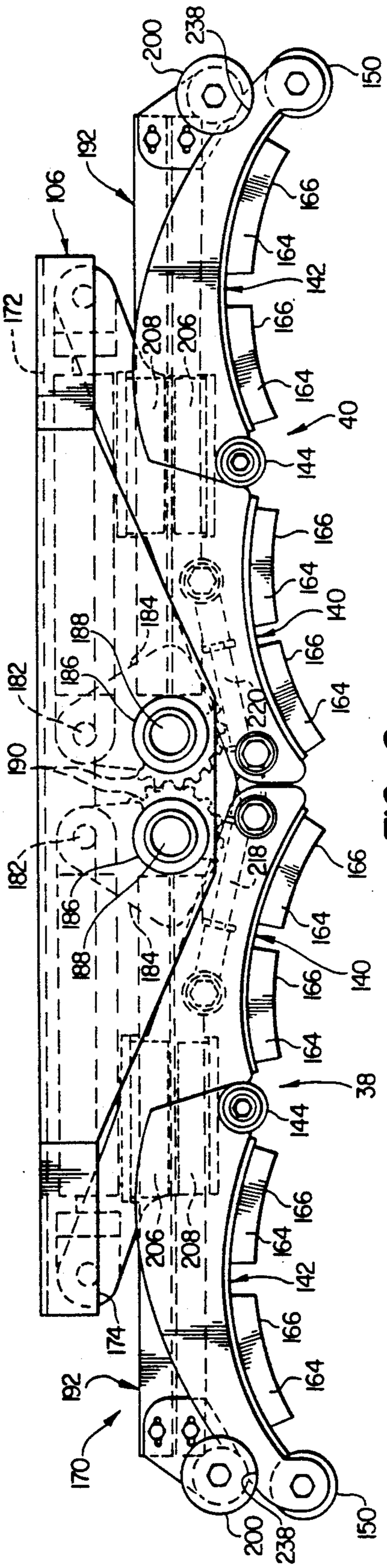
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FIG. 8

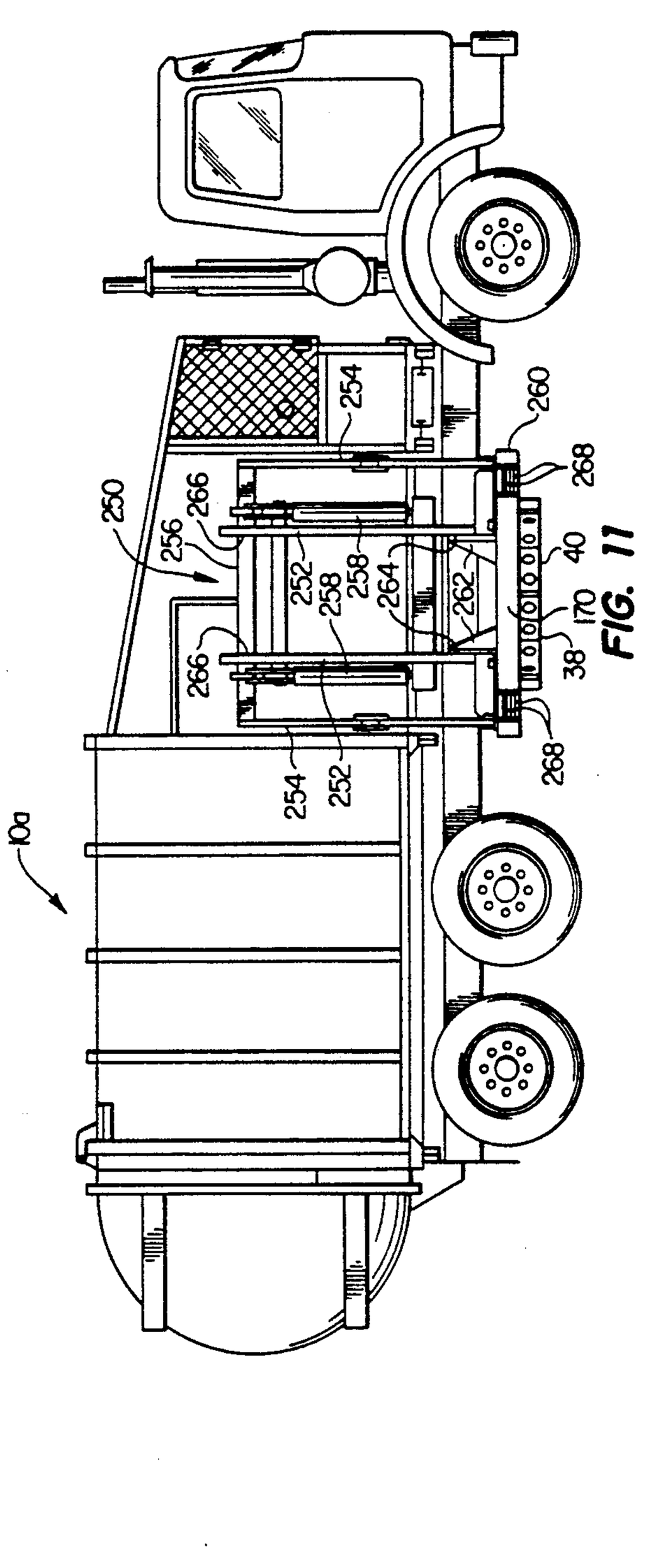
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FIG. 11

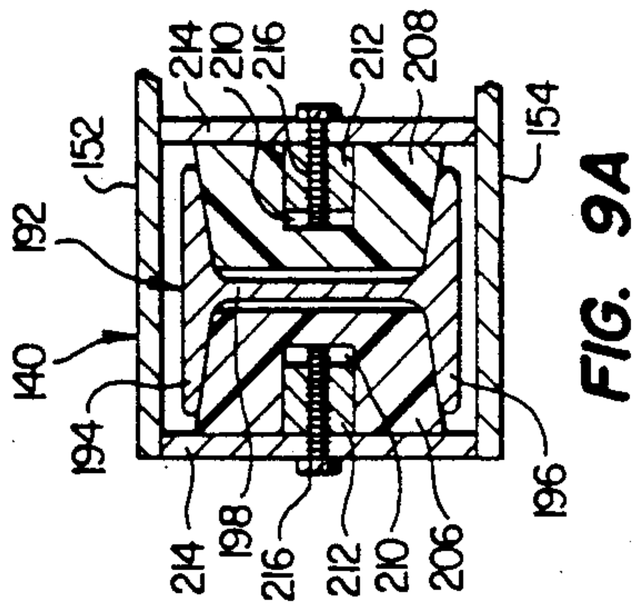


FIG. 9A

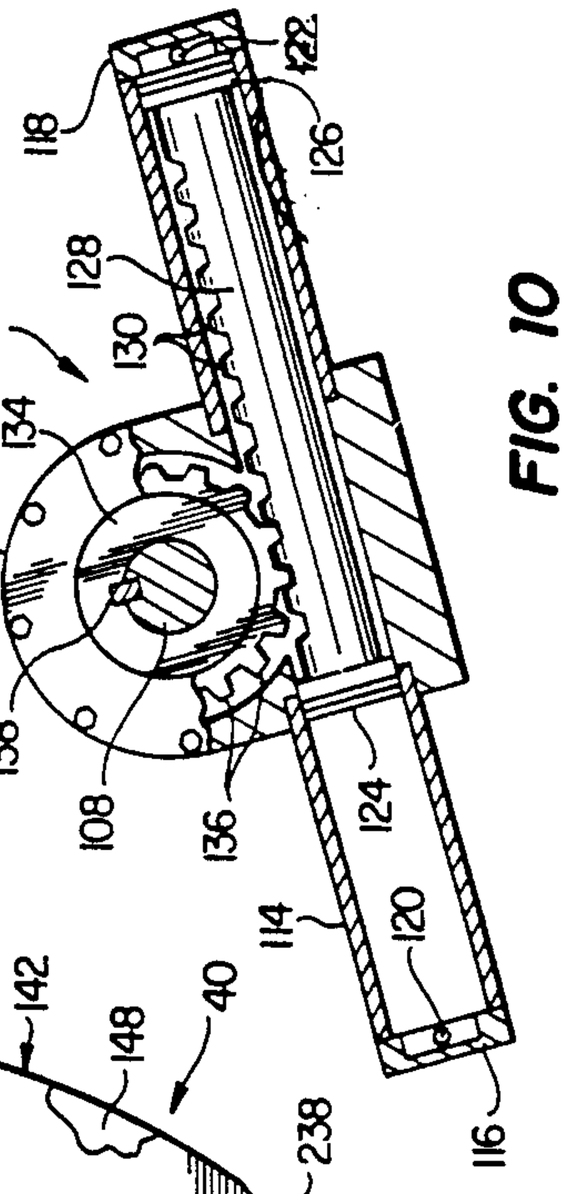


FIG. 10

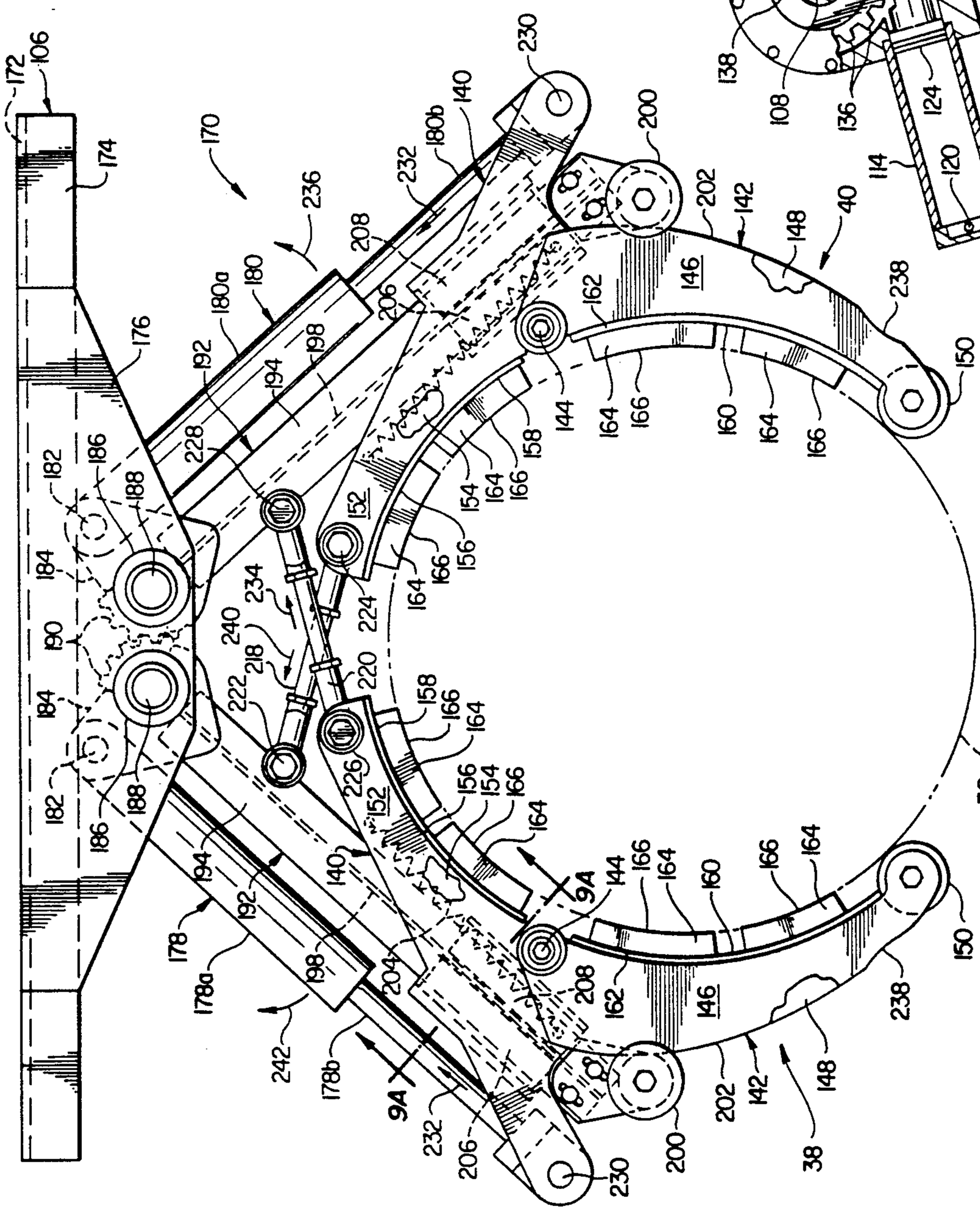


FIG. 9

# CONTAINER HANDLING APPARATUS FOR A REFUSE COLLECTION VEHICLE

## BACKGROUND OF THE INVENTION

The present invention relates generally to mechanized container handling apparatus operatively mounted on over-the-road refuse collection vehicles, and more particularly relates to improvements in a mechanized refuse container handling system of the general type in which a container grasping structure is horizontally extended outwardly away from the vehicle, engages a refuse container, lifts the container and dumps its contents into the hopper portion of the vehicle, lowers the emptied container back to its original position, and then releases the container.

Mechanized container handling systems of this general type are known in the refuse handling art, and an example of such a system is illustrated in U.S. Pat. No. 4,669,940 to Englehardt et al. While mechanized refuse container handling systems of the type described provide valuable time and labor savings, and generally provide satisfactory operation, they have heretofore had a number of problems, limitations and disadvantages, of which the following are but a few.

For example, the horizontal reach limitation of the systems typically requires that the associated collection vehicle be positioned fairly close to the container, and most systems cannot reach past an end of a car or truck parked at the curb adjacent the refuse container. A similar problem exists when a refuse container is spotted at the curb at a small opening between two cars parked along the curb which limits the amount of space available to reach into the space between the cars to retrieve the refuse container without damaging the cars. Additionally, conventional container handling systems are not typically adapted to selectively handle both cylindrical, relatively small refuse containers and much larger, usually rectangular metal containers. As a result, these systems must usually make a first "run" to pick up one type container, and then be modified to make a second run to pick up the other type of container. Also, the pivoted engagement arms used to liftingly engage the cylindrically configured containers contact and grip such containers at only a few widely spaced points around their peripheries, and do not fold back into an essentially straightline position. The operating mechanisms for the container lifting and dumping portion of these systems tend to be fairly complex, large and somewhat difficult and expensive to assemble and dismantle.

In view of the foregoing, it is accordingly an object of the present invention to provide improved refuse container handling apparatus which eliminates or minimizes the abovementioned and other problems, limitations and disadvantages typically associated with conventional container handling systems of the general type described.

## SUMMARY OF THE INVENTION

Various aspects of the present invention, by themselves and in combinations with one another and with a refuse collection vehicle, may be utilized to provide improved refuse container handling apparatus of the type operative to lift a refuse container, dump its contents into a hopper portion of the vehicle, and then return the emptied container to its original resting place. Set forth below are brief summaries of various features of the present invention. The sole purpose of



the following summarization is to provide a general overview of the present invention, and is not to be construed as in any manner limiting its nature or scope.

According to one aspect of the invention, the horizontal reach of the container handling apparatus is substantially increased using a container grasping assembly support structure having three interfitted sections—an inner section anchored to the vehicle, and intermediate section horizontally extensible and retractable relative to the inner section, and an outer section horizontally extensible and retractable relative to the intermediate section and having an outer end operative to horizontally move the container grasping assembly. The intermediate section is horizontally driven relative to the inner section, and means are provided for extending and retracting the outer section relative to the intermediate section in response to driven horizontal movement of the intermediate section. The extended reach capability provided by this structure permits the container grasping assembly to be moved past an end of a parked car or the like, if necessary to grasp a container.

According to another aspect of the invention, a pair of articulated container engagement arms are supported for pivotal movement between an open position, in which the arms are essentially straightened and positioned snugly against the vehicle generally within its width clearance profile, and a closed position in which the arms are outwardly pivoted and positioned to extend around a container and grasp it at a series of points extending around a major portion of an essentially circular path. Drivable linkage means are provided to pivot the articulated engagement arms between their open and closed positions. The linkage means are operative in a manner such that the engagement arms, in their closed position, are operative to uniformly grasp cylindrical containers of differing diameters at circumferentially spaced points around their circular peripheries.

According to a further aspect of the invention, horizontally spaced guide means, preferably in the form of vertical mast members, are provided along which container grasping means may be moved to lift, dump and lower a refuse container operatively engaged by the container grasping means. Drive means are provided for moving the container grasping means along the guide means, the drive means being positioned between the guide means and preferably including a fluid drivable actuator gear-connected to articulated force arms rotationally drivable to lift and lower the container grasping means along the guide means. Guide tracks are preferably formed in the outboard sides of the guide means, thereby permitting easy cross-bracing of the guide means.

According to yet a further aspect of the invention, a container grasping assembly is provided for selectively engaging either a generally cylindrical container or a larger, generally rectangular container so that the collection vehicle can handle both types of container in a single pickup run. The dual container grasping assembly preferably includes a linkage-driven pair of articulated container engagement arms, as described above, for engaging the smaller cylindrical containers, and a pair of supplemental container engagement means positioned outwardly of the opposite ends of the engagement arms in their closed, straightened position and operative to engage the larger rectangular containers.

According to a still further aspect of the invention, the various assemblies of a refuse container handling

system are hydraulically driven, and the necessary hydraulic pumps, valves, controls and the like are contained in a modular power pack structure which may be easily removed from the collection vehicle for repair and maintenance purposes. The module may be rapidly connected to and disconnected from the various hydraulic lines of the system by means of quick disconnect fittings operatively secured to the module.

In addition to their individual advantages, when operatively combined with a suitable refuse collection vehicle the above-described features of the present invention provide an overall refuse collection system which is markedly superior to conventional systems of the general type described.

These and other aspects of the present invention are illustrated in the accompanying drawings and are subsequently described in greater detail herein.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevational view of a refuse collection vehicle on which container handling apparatus embodying principles of the present invention is operatively mounted;

FIG. **2** is a top plan view of the refuse collection vehicle illustrating the greatly improved horizontal reach capabilities of the container handling apparatus;

FIG. **3** is an enlarged scale side elevational view of the container handling apparatus in a lowered, horizontally extended position thereof;

FIG. **4** is a bottom plan view of an extension scissors structure operatively connected to the container handling apparatus and illustrated in FIG. **3**;

FIG. **5** is an enlarged scale side elevational view of the container handling apparatus in a raised, horizontally retracted position thereof;

FIG. **6** is a bottom plan view of the extension scissors structure is its FIG. **5** position;

FIG. **7** is an enlarged scale cross-sectional view through a horizontally extensible and retractable support portion of the container handling apparatus taken along line **7—7** of FIG. **5**;

FIG. **8** is an enlarged scale top plan view of an articulated container engagement portion of the overall container handling apparatus, the container engagement portion being in its open position;

FIG. **9** is a view similar to that in FIG. **8** but with the container engagement portion in its closed position;

FIG. **9A** shows a cross-sectional view of the linkage arm and sliding block connection between the inner engagement arm segment and the linkage arm on the line **9A** shown in FIG. **9**.

FIG. **10** is an enlarged, partially elevational crosssectional view through a lifting/lowering drive portion of the container handling apparatus taken along line **10—10** of FIG. **1**; and

FIG. **11** is a side elevational view of a refuse collection vehicle incorporating improved container handling apparatus adapted for selective handling of either relatively small cylindrical refuse containers or much larger, generally rectangular metal refuse containers.

## DETAILED DESCRIPTION

Illustrated in FIG. **1** is a motorized refuse collection vehicle in the form of an over-the-road motor truck **10** having an operator's cab **12**, and a conventional front steering wheel and axle assembly **14** and tandem rear drive axle and wheel assemblies **16** supporting a frame **18**. The frame **18** supports a refuse collection hopper **20** which may include a suitable compaction mechanism (not illustrated). The hopper **20** includes an opening **22** formed in a side wall portion of the hopper for receiving refuse. The truck **10** is of a type typically used for collection of refuse from residential and commercial areas wherein individual containers are set out at the street curb, and adjacent alleyways or driveways for collection. The containers are typically cylindrical, open-topped metal or plastic cans.

Operatively supported on the truck **10** in a manner subsequently described is an improved container handling apparatus **24** which embodies principles of the present invention. Apparatus **24** is mounted on a container elevating and dumping mechanism **26** (see also FIG. **3**) that is secured to the outer end of a horizontally extensible and retractable support structure **28** supported by the truck frame **18**. In a manner subsequently described, the support structure **28** is operable to move the container and elevating dumping mechanism **26** horizontally between its extended position illustrated in FIG. **3**, and its retracted position illustrated in FIG. **5**.

Representatively illustrated in FIG. **2** is a cylindrical refuse container **30** set out at a curb **32** generally between a representative pair of cars **34** and **36** parked alongside the curb. To empty the contents of the container **30** into the truck hopper opening **22**, the refuse collection truck **10** is pulled outwardly alongside the parked cars **34** and **36** and, in a manner subsequently described, the support structure **28** is moved to its extended position, causing the outer end of the support structure to pass horizontally through the space between the parked cars. After extension of the support structure **28**, a pair of articulated container engagement arm structures **38** and **40**, positioned at the lower end of the container elevating and dumping assembly **26**, are graspingly closed around the container **30**. At this point in time, the container elevating and dumping assembly **26**, and the extensible support structure **28**, are in their orientations depicted in FIG. **3**.

Next, as subsequently described in greater detail, the support structure **28** is retracted to its orientation shown in FIG. **5**, to horizontally move the container **30** to adjacent a lower side portion of the truck **10**, and the elevating and dumping assembly **26** is operated to lift the container **30** to above the hopper opening **22**, and tilt the container **30** in a clockwise direction to dump its contents into the hopper opening **22** as illustrated in FIG. **5**.

The elevating and dumping assembly **26** is then operated to lower the now empty container **30** to ground level, and the support structure **28** is extended to return the container handling apparatus **24** to its FIG. **3** orientation in which the container is returned to its curbside resting place.

Finally, the container engagement arms **38**, **40** are opened to release the container, and the support structure **28** is again retracted to horizontally inwardly move the elevating and dumping assembly **26** to a position closely adjacent the side of the truck **10** facing the cars **34**, **36**. When this final step is accomplished, and the container handling apparatus **24** is returned to the side of the truck, the apparatus is brought to within the normal clearance width profile of the truck as schematically indicated by the dotted line area **24A** in FIG. **2**.

At the outset, it should be noted that one of the various advantages provided by the improved container handling apparatus **24** of the present invention is its extended horizontal reach capabilities which permit it

to grasp and handle the container **30** despite the fact that the refuse collection truck is precluded (by the parked cars **34**, **36**) from pulling directly alongside the curb **32**. This extended horizontal reach capability of the container handling apparatus **24** arises through a unique construction and operation of the extensible and retractable support structure **28** which will now be described.

Referring initially to FIGS. **3** and **7**, the extensible and retractable support structure **28** includes a horizontally inner section **42** suitably anchored to the truck frame **18**, a horizontally intermediate section **44**, and a horizontally outer section **46** having an outer end portion $46_a$ to which a lower end portion of the container elevating and dumping assembly **26** is fixedly secured.

As best illustrated in FIG. **7**, the horizontally inner section **42** of the support structure **28** includes a spaced pair of elongated channel members **48** suitable anchored to the truck frame **18** and having U-shaped cross-sections. A pair of elongated slide block members **50** are anchored to the facing side surfaces of the channel members **48** by means of mounting rails **52** and retaining bolts **54**.

The horizontally intermediate section **44** of the support structure **28** includes a pair of I-beams **56** slidably carried by the mounting rails **50**, as illustrated, and interconnected by transverse channel members **58** welded at their opposite ends to the upper and lower flanges of the I-beams **56**. The mounting of the I-beams **56** on the slide blocks **50** permits the intermediate support structure section **44** to move horizontally inwardly and outwardly relative to the stationary inner support structure section **42**.

The horizontally outer section **46** of the support structure **28** includes a vertically shorter pair of elongated H-beams **60** positioned laterally inwardly of the I-beams **56** and interconnected by transverse channel members **62** welded at their opposite ends to the top flanges of the H-beams **60**. H-beams **60** are slidably mounted on elongated slide block members **64** secured to the vertical webs of the I-beams by mounting rails **66** and retaining bolts **68**. Accordingly, the outer support structure section **46** is slidable into and out of the intermediate support structure section **44** which, in turn, is slidable into and out of the inner support structure section **42**.

The support structure **28** is horizontally drivable between its FIG. **3** extended position and its FIG. **5** retracted position by a hydraulic cylinder actuator **70** positioned horizontally centrally within the support structure **28** and having a cylinder portion **72** anchored at its rear end $72_a$ to the truck frame **18** adjacent the right side of the truck as viewed in FIGS. **3** and **5**, and an actuating rod portion **74**. The outer or left end of the actuating rod **74** is anchored to the intermediate support structure section **44** by a connection block **76** anchored to a longitudinally intermediate portion thereof.

It can be seen by comparing FIGS. **3** and **5** that a hydraulically forced extension of the actuating rod **74** drives the intermediate support structure section **44** outwardly from within the inner support structure section **42**, while hydraulic retraction of the actuating rod **74** draws the intermediate section **44** back into the inner section **42**. A corresponding outward and inward horizontal movement of the outer section **46** relative to the intermediate section **44** into which it telescopes is achieved by linkage means in the form of an extension scissors structure **78** positioned below the support structure **28** (see FIGS. **4** and **6**) and having an outer end **80** anchored to the outer end $46a$ of the outer support structure section **46**, an inner end **82** anchored to the inner support structure section **42** adjacent its outer end, and a central portion **84** anchored to the outer end of the intermediate support structure section **44**.

The scissors structure **78** operates to extend the outer support structure section **46** relative to the intermediate support structure section **44** in response to driven extension of the intermediate section **44**, and to retract the outer section **46** into the intermediate section **44** in response to driven retraction of the intermediate section **44** into the inner support section **42**. Scissors structure **78** also functions to equalize the extension and retraction distances of the sections **44** and **46** relative to the support structure section into which they are telescoped. In this manner, the significantly increased horizontal reach of the container handling apparatus **24** previously discussed in conjunction. with FIG. **2** is achieved. is achieved.

Turning now to FIGS. **1**, **3**, **5** and **10**, the structure and operation of the container elevating and dumping assembly **26**, which is horizontally moved inwardly and outwardly from the side of the truck **10** by the previously described extensible and retractable support structure **28**, will now be described. The assembly **26** includes a horizontally spaced pair of mast members **86** having lower ends $86_a$ and rearwardly and downwardly curved upper end portions $86_b$. Lower portions of the mast members **86**, above their lower ends $86_a$, are anchored to a horizontally extending support member **88** which, in turn, is rigidly secured to the outer end $46_a$ of the outer support structure section **46**. For purposes later described, laterally outwardly facing guide tracks **90** are formed in the mast members **86** and extend from the bottom end $86_a$ of each mast member to its downwardly facing upper end $86_c$. As viewed in FIG. **1**, the guide track **90** in the left mast member **86** is formed along its left side, and the guide track **90** in the right mast member **86** is formed along its right side surface. For purposes later described, support plate members **92** are extended across and anchored to the curved upper portions $86_b$ of the mast members **86**.

The container elevating and dumping assembly **26** also includes a pair of elongated, articulated force arm members **94** positioned outboard of the mast members **86** as best illustrated in FIG. **1**. Each of the force arms **94** has, as viewed in FIG. **3**, an elongated lower segment $94_a$ and an elongated upper segment $94_b$, the inner ends of each associated pair of arm segments being pivotly interconnected as at **96**. The outer or lower ends of the arm segments $94_a$ are pivotly connected, as at **98**, to a pair of support ear structures **100** positioned between each of the force arm segments $94_a$ and its associated mast member **86**. Each of the support ear structures **100** has a pair of roller elements **102**, **104** secured thereto and captively retained in the guide track **90** of their associated mast member **86** for rolling movement along the track between the opposite end portions of the mast member.

The support ear portions **100** are suitably anchored to longitudinally spaced apart portions of a horizontally disposed elongated mounting channel member **106** having a generally U-shaped cross-section. In a manner subsequently described, the container engagement arm structures **38**, **40** are operatively connected to the mounting channel member **106**.

As viewed in FIG. 3, the upper or outer ends of the force arm segments $94_b$ are fixedly secured to a pair of drive shafts **108** which extend inwardly through suitable openings formed in the support plate members **92**, and are rotationally supported on the plate members by bearing structures **110** externally mounted on the plates **92**. In a manner subsequently described, inner end portions of the shafts **108** are drivably secured to a hydraulically powered rotary actuator **112** which is suitably mounted between the support plate members **92** at the upper ends of the mast members **86**.

As best illustrated in FIG. **10**, the rotary actuator **112** comprises an elongated cylinder **114** having closed opposite ends **116**, **118** through which hydraulic fluid inlet ports **120**, **122** are formed. A longitudinally spaced pair of piston structures **124** and **126** are reciprocatively mounted within the cylinder **114** and are anchored to the opposite ends of a rack member **128** having, along its length, a series of upwardly facing teeth **130**.

A generally cylindrical housing **132** projects upwardly from a longitudinally central portion of the cylinder **114** and rotatably supports therein an annular pinion gear **134** having peripheral teeth **136** operatively meshed with the rack teeth **130**. The inner ends of the drive shafts **108** are received within the central opening of the annular pinion gear **134** and are rotationally locked thereto by key members **138**.

Referring now to FIGS. **3**, **5** and **10**, after the support structure **28** has been horizontally inwardly moved from its FIG. **3** extended position to its FIG. **5** retracted position, the refuse container **30** (which is gripped by the container engagement arm structures **38**, **40**) is raised from its lowered FIG. **3** position to its FIG. **5** dumping position by forcing hydraulic fluid from a source thereof into the inlet port **122** to leftwardly drive the pistons **124**, **126** and the rack member **128** through the interior of the cylinder **114**. Such leftward movement of the rack member **128** rotates the pinion gear **134**, and thus the drive shafts **108**, in a clockwise direction as viewed in FIG. **10**. The clockwise driven rotation of the shafts **108** pivots the upper force arm segments $94_b$ in a clockwise direction away from their FIG. **3** positions to their FIG. **5** positions. Clockwise rotation of the upper force arms segments $94_b$ lifts the lower force arm segments $94_a$ while causing them to pivot in a counterclockwise direction relative to the upper force arm segments $94_b$ and move the force arm segments $94_a$ to their FIG. **5** position.

The upward movement of the force arm segments $94_a$, in turn, lifts the support ear structures **100** (and thus the container engagement arms **38**, **40** and the gripped container **30**) and moves the roller elements **102**, **104** upwardly along the guide tracks **90** to ultimately move the container **30** to the upper end portions $86_b$ of the mast members **86** and tilt the container **30** to its refuse dumping orientation illustrated in FIG. **5**.

To lower the now emptied container **30** to its FIG. **3** position adjacent the bottom ends $86_a$ of the mast members **86**, hydraulic fluid is simply forced into the inlet port **20** at the left end of the cylinder **114** (FIG. **10**) to return the rack member **128** rightwardly through the cylinder **114** to cause a counter. clockwise rotation of the pinion gear **134** and the drive shafts **108** to move the articulated force arms **94** from their FIG. **5** orientation back to their FIG. **3** orientation.

The use of the rotary actuator **112**, and its inboard mounting between the support plates **92** coupled with the laterally exterior positioning of the roller elements **102** and **104**, provide the container elevating and dumping assembly **26** with an essentially unimpeded front side portion extending horizontally between the articulated force arms **94**. Additionally, the use of the rotary actuator **112**, together with its previously described inboard mounting position, substantially facilitates the installation of the drive portion of the elevating and dumping assembly **26**.

Specifically, after the rotary actuator **112** has been suitably mounted between the support plate members **92** at the upper ends of the mast members **86**, the drive shafts **108** may be simply inserted inwardly through the support plate openings and rotationally locked to the pinion gear **134**. The bearing structures **110** (FIG. **1**) may then be simply slid inwardly along the outer ends of the drive shaft members **108** and bolted to the exterior of the plates **92**. Finally, the outer ends of the drive shafts **108** can then be fixedly secured to the outer ends of the force arm segments $94_b$.

As best illustrated in FIGS. **8** and **9**, each of the opposed container engagement arm structures **38**, **40** is of an articulated construction comprising inner and outer segments **140** and **142**, the inner ends of the outer arm segments **142** being pivotly connected to longitudinally intermediate portions of their associated inner arm segments **140** by pivot structures **144**. The outer arm segments **142** are each defined by a vertically spaced pair of elongated, generally arcuate top and bottom plate members **146** and **148** which are secured at their outer ends to roller elements **150**. The roller elements and their associated structure comprise camming means to control the articulation of the outer arm segments. The inner arm segments **140** are defined by a vertically spaced pair of elongated, generally straight top and bottom plate members **152** and **154**.

The vertical distance between plates **146**, **148** is slightly greater than the vertical distance between the plates **152**, **154** so that, as illustrated, inner end portions of the plate pairs **146**, **148** overlie and are slidable along portions of their associate plate pairs **152**, **154**. Inner side edges **156** of the plate pairs **152**, **154** have a circularly arcuate configuration and have secured thereto similarly curved vertical plates **158**. In a similar fashion, the plate pairs **146**, **148** have inner side edges **160** having circularly arcuate configurations and a pair of circularly curved vertical plates **162** secured thereto. Radially inwardly projecting arcuate resilient gripping members **164**, each having an arcuate inner side surface **166**, are suitably secured in circumferentially spaced pairs to the curved vertical plates **158** and **162**.

As may be seen by comparing FIGS. **8** and **9**, the container engagement arm structures **38**, **40** are movable between an open position (FIG. **8**) and a closed position (FIG. **9**). In their FIG. **8** open positions, the arm structures **38**, **40** extend in opposite directions and assume generally straight elongated configurations so that the opened arms **38**, **40** may be compactly positioned alongside the truck **10** as may be seen in FIG. **1**. In their FIG. **9** closed position, the arms **38**, **40** are pivoted to generally arcuate orientations in which the closed arms extend around a major circumferential portion of the refuse container **30** and the resilient members **164** are brought into gripping engagement with the refuse container. Importantly, as can be seen in FIG. **9**, the interior side surfaces **166** of the gripping members **164**, with the engagement arms in their closed positions, are disposed around an essentially circular arc portion

so that a very uniform circumferential gripping area on the container **30** is advantageously achieved.

The container engagement arm structures **38**, **40** are operatively secured to the elongated mounting channel member **106** (see also FIGS. **3** and **5**) for movement between their illustrated open and closed positions by a unique, hydraulically actuated linkage system **170** which will now be described in detail with reference to FIGS. **8** and **9**. The channel member **106** has a rearwardly disposed vertical base portion **172** from the top and bottom side edges of which upper and lower flanges **174** forwardly project. Secured to the flanges **174** and projecting forwardly therefrom, are a pair of upper and lower, generally trapezoidally shaped mounting plates **176**.

The linkage system **170** is driven by a pair of hydraulic cylinder actuators **178**, **180** respectively associated with the left and right inner engagement arm segments **140**. Actuator **178** has a cylinder portion $178_a$ and an actuating rod portion $178_b$, and actuator **180** has a cylinder portion $180_a$ and actuating rod portion $180_b$. The inner ends of the cylinders $178_a$, $180_a$ are positioned between the mounting plates **176** and are pivoted at points **182** to connection plate members **184** which are welded to hollow cylindrical collar members **186** rotatably mounted on spaced apart pivot pins **188** anchored at their opposite ends to the mounting plates **176**. For purposes later described, intermeshing gear teeth **190** are formed around the peripheries of the collars **186**.

The linkage system **170** includes elongated I-beam linkage arm members **192** which are positioned inboard of and extend parallel to the hydraulic cylinder actuators **178**, **180** as can be best seen in FIG. **9A**, each of the I-beams **192** having upper and power flanges **194** and **196** interconnected by a vertical web portion **198**. The innermost ends of the I-beams **192** are welded to the connection plate members **184**, and the outer ends of the I-beams **192** have roller structures **200** suitably anchored thereto and rollingly engaging the outer side surfaces **202** of the upper and lower plate portions **146**, **148** of the outer container engagement arm segments **142**. Outer arm segments **142** are pivotly biased into operative engagement with these roller structures **200** by a pair of elongated tension coil spring elements **204** each connected at its opposite ends to an associated pair of bottom plate portions **148** and **154** of the container engagement arm structures **38** and **40**.

For purposes later described, each of the I-beams **192** extends between one of the upper and lower plate pair portions **152**, **154** of its associated inner arm segment **140** as illustrated in FIG. **9A**. Each of the I-beams **192** is slidingly supported between its associated plate pair **152**, **154** by a pair of elongated, tapered slide block members **206**, **208** extending transversely into the I-beam **192** between its flanges **194** **196** on opposite sides of its web **198**. The slide blocks **206**, **208** have generally rectangular slots **210** extending inwardly from their outer side surfaces, the slots **210** receiving a pair of elongated metal guide rail members **212** suitably anchored to opposed side plates **214** extending between and welded to the upper and lower arms segment plates **152**, **154**. To adjust the sliding contact between the side blocks **206**,**208** and the I-beams **192** which they slidably support, adjustment bolts **216** are threaded into tapped openings formed in the guide rails **212** and have inner ends which bear against the inner sides of the slots **210**. The slide blocks **206**, **208** may be forced into the opposite side cavities of the I-beam **192** by tightening the bolts **216**, and a looser engagement between the I-beam and the slide blocks may be achieved simply by loosening the bolts **216**.

The inner ends of the inner engagement arm segments **140** are cross-connected to opposite I-beams **192** by means of a pair of length-adjustable turnbuckle structures **218** and **220**. Specifically, the left end **222** of turnbuckle **218** is fixedly anchored to the left I-beam **192** adjacent its inner end, and the right end **224** of turnbuckle **218** is pivotally connected to the inner end of the right inner engagement arm segment **140**. The left end **226** of turnbuckle **220** is pivotally connected to the inner end of the left inner engagement arm segment **140**, and the right end **228** of turnbuckle **220** is fixedly anchored to the right I-beam **192** adjacent its inner end. As illustrated, the outer ends of the actuating rods $180_b$ are pivotally connected, at points **230**, to the outer ends of their associated inner engagement arm segments **140**.

To describe the unique operation of the hydraulically actuated linkage system **170**, it will be assumed that the container engagement arm structures **38**, **40** are in their fully closed position as depicted in FIG. **9**. With the engagement arms **38**, **40** in this closed grasping position, the actuating rods $178_b$, $180_b$ are fully extended, and the roller structures **200** on the outer ends of the I-beams **192** are longitudinally adjacent the outer ends of the inner engagement arm segments **140**. Additionally, the hydraulic actuators **178**, **180** are downwardly and horizontally outwardly sloped relative to the mounting channel **106** (as viewed in FIG. **9**), and the slide block pairs **206**, **208** carried by the inner arm segments **140** are positioned adjacent the outer ends of their associated I-beams **192**. In this extended reach position it is seen that the inner and outer arm segments which comprise the engagement arms are moved outwardly away from the support member and at the same time pivoted inwardly toward each other to grasp a container spaced some distance away from the support member.

To rearwardly pivot the container engagement arm structures **38**, **40** from their FIG. **9** closed positions to their FIG. **8** open positions in which the arms **38**, **40** are essentially straightened and positioned parallel to and adjacent the channel member **106**, pressurized hydraulic fluid from a source thereof is forced into the cylinders $178_a$, $180_a$ to initiate retraction of the actuating rods $178_b$, $180_b$ as indicated by the directional arrows **232**. Retraction of the left actuating rod $178_b$ exerts, via the left inner engagement arm section **140** and the turnbuckle **220**, a generally rightwardly directed force **234** on the right I-beam **192** which initiates a counterclockwise pivoting **236** of the actuator **180**, the right I-beam **192**, and the right inner engagement arm segment **140** toward the mounting channel member **106**. During this pivotal movement **236**, the right slide block pair **206**, **208** slides leftwardly and upwardly along the right I-beam **192** as viewed in FIG. **9**. Also during this counterclockwise pivotal movement **236**, the right outer engagement arm segment **142** is pivoted in a counterclockwise direction relative to the right inner engagement arm segment **140** due to the outward biasing force of the right spring elements **204**, whereby the right outer engagement arm segment **142** is maintained in contact with the right roller structure **200** which rolls outwardly along the right side edges **202** toward detent indentations **238** formed therein adjacent their outer ends.

A similar movement of the left side of the illustrated linkage system **170** is achieved in response to retraction

of the right actuating rod $180_b$. Specifically, upon such retraction of the right actuating rod $180_b$, a force **240** is generated, via the turnbuckle **218** and the right inner engagement arm section **140**, which acts on the left I-beam **192** to pivot it in a clockwise direction as indicated by the arrow **242**. Clockwise pivotal movement of the left I-beam **192** correspondingly pivots the left actuator **178** and the left engagement arm segments **140** and **142**, the left outer arm segment **142** being maintained in contact with the left roller structure **200**, by the left spring **204**, as the left roller structure **200** rolls along the outer side edges **202** of the left arm segment **142** toward detent depressions **238** formed therein.

Thus it is seen that retraction of the actuating rods causes the pair of articulated arms **38**, **40** to open to move inwardly with respect to the support structure while the pair of inner arm segments **140** slide along the linkage arm members **192** and are retracted and move closer to the support member as the linkage arms **192** move from the angled position of FIG. **9** to lie oppositely in straight line orientation along the support member in the position shown in FIG. **8**. The extended grasping position of FIG. **9** is achieved within the space defined by the overall width of the oppositely extended engagement arms in the open position of FIG. **8** because as the linkage arms are pivoted the articulated engagement arms simultaneously come towards each other and slide along the linkage arms as the slide block means connecting the inner arm segments to the linkage arms move from the inner end portions of linkage arms **192** to the outer end portions as shown in FIGS. **8** and **9**.

When both of the actuating rods $178_b$ and $180_b$ have been fully retracted as indicated in FIG. **8**, the I-beams **192**, the actuators **178** and **180**, and the container engagement arms **38**, **40** are brought to their open positions, are closely adjacent the channel member **106**, and extend generally parallel to the channel member **106**. The slide block pairs **206**, **208** have been moved inwardly along their associated I-beams **192**, and the roller structures **200** are received in their associated edge detent depressions **238** on the outer arms segments **142**.

To move the container engagement arms **38**, **40** from their FIG. **8** open positions to their FIG. **9** closed positions, the actuating rods $178_b$ and $180_b$ are simply extended again which reverses the positional sequencing of the linkage system **170** just described.

The previously described adjustable slide block pairs **206**, **208** advantageously function to add rigidity to the linkage system **170**. Specifically, such slide block pairs function to inhibit undesirable horizontal tilting of the arms **38**, **40** relative to the linkage system **170**. The desirable stabilizing effect of the slide block pairs **206**, **208** is maintained throughout the motion range of the engagement arm structures **38**, **40** from their open positions to their closed positions. Pivotal synchronization of the left and right sides of the linkage system **170** is facilitated by the intermeshing gear teeth **190** on the collar members **186**.

It will be readily appreciated that the linkage **170** just described advantageously employs, in a compact fashion, linear force inputs to cause the pivotal and straightening motions of the arms **38**, **40** as they are moved from their open position to their closed position, and create a reverse pivotal and straightening motion of the engagement arms when they are moved from their closed position to their open position. While it is preferable that both of the actuators **178**, **180** be used, it will be appreciated that, due to the unique cross-connection between the opposed linkage halves, one of the actuators could be eliminated if desired.

For purposes of illustrative clarity, various conventional hydraulic components, such as hydraulic lines, pumps, reservoirs and the like required to operate the previously described container handling apparatus **24** have been omitted from the drawings. According to a feature of the present invention, various key central components of the overall hydraulic system associated with the container handling apparatus **24**, such as pumps, reservoirs, valves and the like are conveniently housed in a removable hydraulic module structure **244** (FIG. **1**) detachably mounted on a top front portion of the refuse collection hopper **20** and supported on a suitable frame structure. The various flexible hydraulic lines used to power the container handling apparatus **24** may be conveniently connected to and removed from representative quick disconnect fittings **248** projecting outwardly from the module **244**, thereby permitting the module, and the hydraulic equipment housed therein, to be easily separated from its hopper mounting structure and removed for repair and maintenance purposes. When these tasks are completed, the module **244** may be simply repositioned on its frame structure and the hydraulic lines reconnected to the fittings **248**.

Illustrated in FIG. **11** is a refuse collection truck $10_a$ similar to the truck **10** in FIGS. **1** and **2**. Operatively mounted on the truck $10_a$ is a container handling system **250** similar to that illustrated and described in U.S. Pat. No. 4,669,940 to Inglehardt et al, the apparatus **250** including a pair of vertical mast members **252** positioned inboard of a pair of articulated drive arms **254** connected at their upper ends to an elongated drive shaft **256** extending through upper ends of the mast members **252** and driven by hydraulic cylinder actuators **258** positioned between the masts **252** and the arms **254** as illustrated. The lower ends of arms **254** are secured to the opposite ends of a horizontal support member **260**. A pair of support structures **262** are secured to the member **260** and have roller structures **264** captively retained in guide tracks **266** formed on the inner side surfaces of the masts **252**. As more fully described in U.S. Pat. No. 4,669,940, operation of the actuators **258** causes the support member to be moved upwardly or downwardly along the masts **252**.

Secured to opposite end portions of the support member **260** are horizontally extending pairs of metal pins **268** which may be engaged with the spaced latch hook structures on a typical relatively large retangular metal trash container, the system **250** being adapted to lift and rearwardly tilt the retangular container to empty its contents into the hopper portion of the truck $10_a$.

In accordance with a further aspect of the present invention, the previously described container engagement arm structures **38** and **40**, and the previously described drive linkage **170**, are secured to the support member **260**. This incorporation of the arms **38**, **40** and the linkage system **170** into the container handling system **250** advantageously provides it with the ability to handle either cylindrical refuse containers or considerably larger rètangular metal containers without having to adjust or otherwise modify the system to change it over from one type of container to the other.

The foregoing detailed description is to be clearly understood as being given by way of illustration and example only, the spirit and scope of the present invention being limited solely by the appended claims.

What is claimed is:

1. Apparatus for selectively grasping and releasing an object, such as a refuse container, comprising:

a support member;

first and second articulated object engagement arm structures each including inner and outer longitudinal segments pivotally connected at fixed points thereon and having inner side portions from which resilient gripping members outwardly project;

first and second linkage means connecting respectively said first and second engagement arm structures to said support member, said linkage means being responsive to predetermined, generally linear forces exerted on at least one of said engagement arm structures to cause pivotal movement of said engagement arm structures relative to said support member between an open position in which said engagement arm structures are generally straightened and extend in opposite directions, and a closed position in which said engagement arm structures are in a generally opposed relationship, with said outer first and second engagement arm segments being inwardly pivoted relative to their associated inner segments, and said gripping members are brought to positions in which they will engage the object at spaced locations around its periphery;

said inner engagement arm segment of at least one of said first and second engagement arm structures being supported by sliding support means along an elongated portion of its respective linkage means for sliding supported movement therealong during pivotal movement of said engagement arms between said open and closed positions;

drive means for exerting said predetermined, generally linear forces on said at least one of said engagement arm structures.

2. The apparatus of claim 1 in combination with an over-the-road refuse collection vehicle.

3. The apparatus of claim 1 wherein:

said engagement arm structures have inner side surfaces to which a longitudinally spaced series of said resilient gripping members are secured, and

said gripping members are positioned around a major portion of a substantially circular path when said engagement arm structures are in their closed position.

4. The apparatus of claim 3 wherein:

said inner side surfaces of said engagement arm structures, and said gripping members, are arcuately shaped.

5. The apparatus of claim 1 wherein:

said drive means include a fluid operable cylinder and rod actuator interconnected at opposite ends to said support member and the inner longitudinal segment of one of said engagement arm structures.

6. The apparatus of claim 1 wherein said respective linkage means includes a cam means for camming outer side surfaces of the outer container engagement arm segments to control their pivotal movement during opening and closing of the engagement arms.

7. Apparatus for selectively grasping and releasing an object, such as a refuse container, having a generally circular-cross-section said apparatus comprising:

a support member;

first and second articulated object engagement arm structures each including pivotally interconnected inner and outer longitudinal segments having inner side surfaces to which object gripping members are secured;

first and second linkage means connecting respectively said first and second engagement arm structures to said support member, said linkage means being responsive to predetermined, generally linear forces exerted on at least one of said engagement arm structures to cause pivotal movement of said engagement arm structures relative to said support member between an open position in which said engagement arm structures extend in opposite directions, and a closed position in which said engagement arm structures are in a generally opposed relationship, with said outer engagement arm structures being inwardly pivoted relative to their associated inner segments, and said gripping members are substantially entirely disposed around a generally circular arcuate path to inwardly and uniformly grip the generally circularly cross-sectioned object around a major part of the circular peripheral portion thereof;

said inner engagement arm segments of said first and second engagement arm structures being slidingly supported by sliding support means along an elongated portion of their respective linkage means for slidingly supported movement therealong during pivotal movement of said engagement arms between said open and closed positions so that said engagement arms move outwardly away from said support member and move toward each other to provide an extended reach for gripping said object; and

drive means for exerting said predetermined generally linear forces on said at least one of said engagement arm structures.

8. The apparatus of claim 7 in combination with an over-the-road refuse collection vehicle.

9. The apparatus of claim 7 wherein:

said linkage means include means for utilizing a pivotal force imposed on one of said engagement arm structures to create an oppositely directed pivotal force on the other of said engagement arm structures.

10. The apparatus of claim 7 wherein:

said linkage means include means for pivotally synchronizing said engagement arm structures as they are moved between their open and closed positions.

11. The apparatus of claim 10 wherein:

said means for pivotally synchronizing include intermeshed first and second gear means each operatively associated with a different one of said engagement arm structures.

12. The apparatus of claim 7 wherein:

said drive means include fluid operable cylinder and rod actuator means connected between said support member and said engagement arm structures.

13. The apparatus of claim 12 wherein:

said fluid operable cylinder and rod actuator means are associated with said engagement arm structures for pivotal motion therewith.

14. The apparatus of claim 7 wherein:

said drive means include a fluid operable cylinder and rod actuator operatively interconnected between said support member and the inner longitudinal segment of one of said engagement arm structures.

15. Apparatus for selectively grasping and releasing an object, such as a refuse container, comprising:

a support member;
elongated first and second linkage members pivotally connected at inner ends thereof to said support member and having outer end portions, said first and second linkage members being pivotable relative to said support member between a rear position in which said first and second linkage members longitudinally extend in opposite directions, and a front position in which said first and second linkage members are forwardly pivoted and form an angle therebetween;
first and second object engagement arm structures each having an inner longitudinal segment and an outer longitudinal segment pivotally secured to said inner longitudinal segment, said engagement arm structures having inner side portions to which container gripping members are secured, said inner longitudinal segments of said first and second engagement arm structures being respectively secured to said first and second linkage members for movement along their lengths, said outer longitudinal segments of said first and second engagement arm structures, respectively, being pivotally outwardly biased into engagement with said outer end portions of said first and second linkage members;
a first cross member secured at spaced apart portions thereof to said inner longitudinal segment of said first engagement arm structure and said second linkage member;
a second cross member secured at spaced apart portions thereof to said inner longitudinal segment of said second engagement arm structure and said first linkage member; and
a first extensible and retractable drive structure interconnected between said support member and one of said inner longitudinal segments of said first and second engagement arm structures,
said first drive structures being retractable to move said first and second linkage members to their rear positions and move said first and second engagement arm structures to an open position in which they are generally straightened and longitudinally extend in opposite directions generally parallel to said first and second linkage members,
said first drive structure being retractable to move said first and second engagement arm structures from their open position to a closed position in which said first and second engagement arm structures are in a generally opposed relationship, with said other longitudinal engagement arm segments being inwardly pivoted relative to their associated inner longitudinal segments, and said gripping members being positioned to operatively grip the object at spaced points around its periphery.

**16**. The apparatus of claim **15** in combination with an over-the-road refuse collection vehicle.

**17**. The apparatus of claim **15** wherein:
each of said first and second cross members has an end portion pivotally secured to one of said inner longitudinal engagement arm segments.

**18**. The apparatus of claim **17** wherein:
said first and second cross members are length adjustable turnbuckle members.

**19**. The apparatus of claim **15** further comprising:
means for pivotally synchronizing said engagement arm structures during pivotal movement thereof between said open and closed positions.

**20**. The apparatus of claim **19** wherein:
said means for pivotally synchronizing include intermeshing gear means associated with said first and second linkage members and rotatable by said first and second linkage members during pivotal movement thereof between said front and rear positions.

**21**. The apparatus of claim **15** wherein:
the inner longitudinal segments of said first and second engagement arm structures have anchored thereto spaced pairs of support slide members which respectively and slidingly engage said first and second linkage members.

**22**. The apparatus of claim **21** wherein:
said first and second linkage members are elongated beam members each having opposite side cavities extending along its length and receiving one of said spaced pairs of said support slide members, and
said apparatus further comprises means for laterally adjusting said support slide members relative to their associated linkage members.

**23**. The apparatus of claim **15** wherein:
said apparatus further comprises a second extensible and retractable drive structure interconnected between said support member and the other of said inner longitudinal segments of said first and second engagement arm structures.

**24**. The apparatus of claim **23** wherein:
said first and second drive structures are respectively associated with said first and second engagement arm structures for pivotal motion therewith.

**25**. The apparatus of claim **24** wherein:
said first and second drive structures are fluid-operable cylinder and rod actuators which respectively extend parallel to said elongated first and second linkage members.

**26**. Apparatus for selectively reaching out to grasp and retracting to release an object, such as a refuse container, comprising:
a support member which may be fixed to the side of a vehicle such as a refuse truck;
a linkage system comprising a pair of elongated linkage arms having inner and outer ends, the inner ends being pivotally connected to said support member, said arms being pivotable relative to said support member between a first position wherein said arms are oppositely extended along the support member in a generally straightened position and a second position wherein the linkage arms are pivoted outwardly with the outer ends of the pair of arms being positioned outwardly away from said support member;
a pair of articulated oppositely disposed engagement arm structures, each engagement arm having an inner arm segment and an outer arm segment pivotally connected to the inner arm segment, the pair of articulated arm structures being slidingly mounted on said linkage system for movement therewith by sliding connections between the inner arm segments and the elongated linkage arms so that said engagement arms open and are drawn close to said support member when the linkage system arms are pivoted to the first position and upon pivoting of the linkage arms away from the support member, said engagement arms simultaneously move outwardly away from the support member and toward each other to an extended reach position for grasping an object; and
drive means for pivoting said linkage arms and said engagement arms between said first position and

said outwardly angled second position of said linkage arms to simultaneously move the engagement arms outwardly away from the support member and into an extended reach grasping orientation.

**27**. The apparatus of claim **26** in combination with an over-the-road refuse collection vehicle.

**28**. The apparatus of claim **26** wherein said respective linkage means includes a cam means for camming outer side surfaces of the outer container engagement arm segments to control their pivotal movement during opening and closing of the engagement arms.

**29**. The apparatus of claim **26** wherein:

said engagement arm structures have inner side surfaces to which a longitudinally spaced series of resilient gripping members are secured, and

said gripping members are positioned around a major portion of a substantially circular path when said engagement arm structures are in their closed position.

**30**. The apparatus of claim **29** wherein:

said inner side surfaces of said engagement arm structures, and said gripping members, are arcuately shaped.

**31**. The apparatus of claim **26** wherein:

said linkage system includes means for utilizing a pivotal force imposed upon one of said engagement arm structures to create an oppositely directed pivotal force on the other of said engagement arm structures.

**32**. The apparatus of claim **26** wherein:

said linkage arms include means for pivotally synchronizing said engagement arm structures as they are moved between their open and closed positions.

**33**. The apparatus of claim **32** wherein:

said means for pivotally synchronizing include intermeshed first and second gear means each operatively associated with a different one of said engagement arm structures.

**34**. A grasping arm assembly for being carried on a supporting structure in an open oppositely extended generally straight line orientation and moveable to a closed position extended away from the support to structure selectively grasp and release an object, such as a refuse container, the assembly comprising:

a support member capable of being mounted along the side of a vehicle;

a pair of elongated linkage arms having inner and outer end portions, the inner ends pivotally connected to the support member adjacent to each other, the linkage arms being pivotable between an open position in which the linkage arms are extended oppositely in a straight line orientation and a closed position wherein the linkage arms are angled away from the support member toward each other in order to cause engagement arms mounted on each of the linkage arms to grasp a container;

opposed engagement arms for selectively grasping and releasing a container in response to pivotal movement of the linkage arms from the open to the closed position, the engagement arms being oppositely extended from each other when the linkage arms are pivoted to the open position;

first sliding support means for connecting one of the engagement arms to one of the linkage arms and second sliding support means for connecting the other of the engagement arms to the opposite other linkage arm, wherein the engagement arms are slidingly supported by the linkage arms adjacent the inner ends of the linkage arms with the linkage arms pivoted to the open position and slidingly supported by the linkage arms adjacent the outer ends of the linkage arms when the linkage arms are pivoted to the closed position for grasping a container;

drive means for pivoting the pair of linkage arms between the open and closed positions; and

wherein pivotal movement of the linkage arms between the open and closed position causes the engagement arms to slide outwardly on the linkage arms and away from the support member to an extended reach grasping position when the linkage arms are in the closed position so that the combined sliding and pivotal motion of the engagement arms reduces the amount of clear space otherwise required to operate the device.

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UNITED STATES PATENT AND TRADEMARK OFFICE

# CERTIFICATE OF CORRECTION

PATENT NO. : 5,092,731
DATED : March 3, 1992
INVENTOR(S) : Jones, et al.

It is certified that error appears in the above-indentified patent and that said Letters Patent is hereby corrected as shown below:

Column 6, line 20, delete "is achieved." after ". . . FIG. 2 is achieved."

Column 11, line 15, delete "to" after "to open" and add --and--.

Column 14, line 14, delete "struc-" and add --segments--.

Column 14, line 15, delete "tures".

Column 15, line 50, delete "other" and add --outer--.

Column 17, line 45, delete "to" and add --structure to--.

Column 18, line 1, delete "structure".

Signed and Sealed this

Seventh Day of December, 1993

*Attest:*

BRUCE LEHMAN

*Attesting Officer*

*Commissioner of Patents and Trademarks*